Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/JP05/008821

International filing date: 09 May 2005 (09.05.2005)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/668,237
Filing date: 04 April 2005 (04.04.2005)

Date of receipt at the International Bureau: 29 September 2005 (29.09.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

07. 9. 2005
PCT/JP2005/008821

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August 10, 2005

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APPLICATION NUMBER: *60/668,237*
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. ER559458466US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
	NAGAR et al.	

Additional inventors are being named on the ______ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max):

Universal Disk Format (UDF) on Write-Once Media Without a Virtual Allocation Table (VAT)

11258 U.S.PTO 60/668237 040405

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OR

☐ Firm or Individual Name

Address

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Country	Telephone	Fax

ENCLOSED APPLICATION PARTS *(check all that apply)*

☐ Application Data Sheet. See 37 CFR 1.76
☑ Specification *Number of Pages* 6
☑ Drawing(s) *Number of Sheets* 5
☐ CD(s), Number of CDs ______
☐ Other (specify) ______

Application Size Fee: If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

METHOD OF PAYMENT OF FILING FEES AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.
☐ A check or money order is enclosed to cover the filing fee and application size fee (if applicable).
☐ Payment by credit card. Form PTO-2038 is attached
☐ The Director is hereby authorized to charge the filing fee and application size fee (if applicable) or credit any overpayment to Deposit Account Number: ______. A duplicative copy of this form is enclosed for fee processing.

TOTAL FEE AMOUNT ($) ______

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
☑ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

SIGNATURE Albert S. Michalik   Date April 4, 2005

TYPED or PRINTED NAME Albert S. Michalik   REGISTRATION NO. 37395 *(if appropriate)*

TELEPHONE (425) 836-3030   Docket Number: 4670

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

In re Application of NAGAR et al.
Attorney Docket No. 4670

CERTIFICATE OF MAILING BY "EXPRESS MAIL"

"Express Mail" mailing label number ER559458466US

Date of Deposit: April 4, 2005

I hereby certify that the following documents:

Provisional Patent Application in the name of NAGAR et al. For: "FILE SYSTEM ALLOCATION STRATEGY ON WRITE-ONCE MEDIA USING MULTIPLE WRITE POINTS," including:

Certificate of Express Mail (1 pg), Provisional Cover Sheet (1 pg), 6 pages Specification, 4 pages drawings, Application Data Sheet (3 pgs), and Return Postcard.

are being deposited with the United States Postal Service "Express Mail Post Office To Addressee" Service under 37 C.F.R. 1.10 on the date indicated above and is addressed to: Assistant Commissioner for Patents, Alexandria, VA 22313-1450.

Karolina Kapa
(Typed or printed name of person mailing paper or fee)

(Signature of person mailing paper or fee)

4670 express mail cert

Title: Universal Disk Format (UDF) on Write-Once Media Without a Virtual Allocation Table (VAT)

Field of the Invention:
In general, the present application relates to computer software and optical media and in particular, to a universal format for write-once media without utilizing a virtual allocation table.

Introduction:

The use of the Universal Disk Format (UDF) on write-once or incremental media currently requires the file system to implement and store a Virtual Allocation Table (VAT) in order to handle overwrites of existing data. The management of the VAT must be implemented by everyone who wishes to write a UDF file system driver.

Strategic Importance of the Idea:

By having the device handle the overwriting of existing blocks, the file system does not need to implement this logic; except for backwards compatibility. This reduces the complexity of the file system driver.

Description of the Idea:

Devices would handle the overwriting of existing data by writing the new data to the next writable block and creating an entry in a table stored by the drive. The file system would continue to use the same logical block number, and the drive would remap the request to the new location based on the entry in the table. In order to reduce the size of this table, the file system would not reuse blocks after they are freed. That is, the file system would have to be aware that it is using write-once media, and adjust its behavior accordingly. The new implementation of UDF would be almost identical to the current implementation on write-once media. The exception is that the file system would not have to use a VAT. It could rewrite blocks as needed, and the device would handle the remapping below it.

The though behind this idea is that the device would use the normal volume space to store the remapped data. That is, it is writing to the next writable location within the same track that the original block exists. The file system would query the device for the next writable block whenever it needs to allocate new space. So both the file system and the device are sharing the same space for writes. This is not a requirement, however.

Applications of the Idea:

This idea could be used to make the UDF file system less complicated. Since the remapping of rewritten blocks has been offloaded to the device, the file system does not need to do it. This also provides more consistency between UDF implementations. There would only be a handful of versions of the chip with this logic that the various devices would use.

This idea could allow for faster and/or more robust remapping, since it could be done by dedicated hardware.

Further Description:

Hereinafter, a recording method according to the above idea will be described as embodiments.

Figures 1 shows the difference from a conventional technology for rewritable media.

As shown in Figure 1 (a), rewritable media has Spare Area. For example, when logical sectors at address A and B are defective, the data is replaced within Spare Area. If the data is replaced within volume space as shown in Figure 1 (b), the logical sector assigned as replaced can not be used any more. Thus, the above idea is not applied for rewritable media, because all sectors in volume space are provided as defect free logical space, and all sectors shall be overwritable logically.

On the other hand, write-once media may not guarantee to provide defect free logical space like rewritable media, because once a physical sector is recorded, the sector can not be overwritten. Therefore, this idea is suitable for write-once media as shown in Figure 1 (c). The data is recorded sequentially from the top of the track. If a logical sector of address A is a defective sector, the data is remapped to the sector of next address C. After some data is recorded, the recorded logical sector of address B can be overwritten logically to the next writable address D. Thus, this idea is not require to change logical address assignment as the remapped data can be recorded at next writable address.

If the method to replace within Spare Area is applied for write-once media, all available media capacity may not be used, due to the pre-assigned size of Spare Area.

Figure 2 shows the recording method to reduce the size of entry table to indicate remapping information. As shown in Figure 2 (a), after the data is recorded up to the address B, the recorded logical sector at address A is instructed to be overwritten, the data is recorded at next writable address C. At this moment, file system does not know where the data is replaced. If file system wants to record the data to the next writable address, the data is remapped and recorded to the next sector at address D. As one entry is used at one remapping, file system checks the updated next writable address before any data is recorded barring overwrite, and instruct to write the data at the next writable address D, as shown in Figure 2 (b). File system will not also re-allocate to the deleted file area, barring requirement to overwrite from the same reason.

Figure 3 is diagram showing a configuration of areas to explain above mentioned remapping.

Defect Management Area (DMA) is an area, in which information (entry) indicating the correspondence between the address of a block to be replaced and the address of a replaced block in a replacement record operation, is recorded in the form of a defect list (entry table).

Temporary DMA (TDMA) is an area, in which a temporary defect list is recorded in a incremental write operation. When a disc is finalized to prohibit incremental write operations, a temporary defect list is registered on a defect list of DMA. DMA is provided in two portions of a disc, i.e., at an inner portion and at an outer portion. Thus, a replacement list is recorded in different areas twice. In TDMA, disc information, such as track information, positional information of a spare area, and the like, are recorded.

Spare Area is a replacement area, in which data is recorded by equivalent method to linear replacement algorithm. The replacement area is assigned inside a volume space. Although, addresses in the spare area are inherently specified by using physical addresses, for the sake of simplicity, addresses in the spare area are indicated by SA's (Spare area Address). Sectors on and after SA #m+1 are in the unrecorded state.

The volume space consists of three tracks. A track is an area in which the data is recorded sequentially from the beginning of the track on a write-once disc. The start address of unrecorded area in a track is managed as Next Writable Address (NWA). "Close" and "Resserved" indicates a status of a track. Close means that all sectors in a track have been used for recording data. Reserved means that there is a sector(s), which has not been used for recording data. In other words, data can be incrementally written into an

reserved track.

Volume Structure is a volume structure of UDF 2.5. A volume structure, which is located at an area having a smaller logical sector number, includes Anchor Volume Descriptor Pointer, Volume Recognition Sequence, Volume Descriptor Sequence. A volume structure, which includes the second Anchor Volume Descriptor Pointer and the reserved Volume Descriptor Sequence may be recorded the end of volume space, although this volume structure is not described in Figure 3. The Logical Volume Integrity Descriptor recorded in a Logical Volume Integrity Sequence is a part of a volume structure. However, for convenience of explanation, the Logical Volume Integrity Descriptor is explicitly described under the volume structure. Since the volume structure has been previously recorded, Tracks #1 is a closed track. Track #2 is assigned for Metadata File for metadata recording. The Metadata File is also called a Metadata partition. Track #3 is an incomplete track for user data recording.

A file structure will be described below.

Metadata Bitmap FE (Metadata Bitmap file File Entry) is a File Entry for managing a Metadata Bitmap. Metadata Bitmap is a bitmap for managing available sectors which are ready for use in a Metadata file. Not only unrecorded areas but also an area, which becomes an unnecessary area by updating file management information, are registered in the bitmap as available areas. Metadata File FE (Metadata File File Entry) is a File Entry for managing allocated areas of a Metadata File. In a Metadata File, a File Entry for managing a file and directory information are recorded. A File Set Descriptor is also recorded, which is not described herein. Root directory FE is a File Entry for managing information of the recorded position of the root directory.

An exemplary procedure for updating Data-A file and recording Data-B file onto the write-once optical disc will be described.

At first, the Metadata Bitmap is read into a memory and is updated in the memory to obtain a recording area in the Metadata file. Then, a directory, under which a file is to be stored, is read into the memory, and is updated in the memory. In this example, the root directory is read out, and the Data-B file is added.

The File Entry of the directory is read into the memory, and information (e.g., size and update time, etc.) of the directory is updated. Then, the Data-A file data is overwritten logically, and physically recorded from the beginning of the unrecorded area in Track #3 as Data-A', and Data-B file data is written from next writable address in Figure 3.

The replacement record operation is a pseudo-overwrite operation of the present invention. As used herein, the term "pseudo-overwrite operation" refers to a logical overwrite operation, in which the mechanism of a replacement record operation is used to record data into a Spare area or into next writable address in the track in response to an instruction to record data into an already recorded area. Where, VA (Virtual Address) indicates an address within a Metadata file. Information indicating which sectors are remapped is recorded in TDMA.

In order to register the positional information of the recorded data, the File Entries of the files is generated in the memory.

The data updated or generated in the memory is recorded. In the example of Figure 3, a drive apparatus is instructed to record the Metadata Bitmap file in the same place. Since the specified area is an already-recorded area, the drive apparatus records the data at SA #m, which is the beginning of the unrecorded area in the spare area.

The Data-A FE is overwritten logically by remapping the data to the next writable address. And the Data-B FE is recorded to the updated next writable address.

It is instructed that the root directory is recorded at VA #k+3. Therefore, the root directory recorded at VA #i+1 becomes invalid, and the VA #i+1 sector becomes an available sector in a logical space.

It is instructed that File Entry of the root directory is recorded into VA #i. In this case, VA #i is an already-recorded area, therefore, the data is recorded into VA #k+4 by a pseudo-overwrite operation.
It is instructed that the Logical Volume Integrity Descriptor is updated to indicate the integrity state of the file management information. The data is recorded into SA #m+1 by a pseudo-overwrite operation.

Metadata Bitmap and Logical Volume Integrity Descriptor may be also remapped into another track (ex. Track #2), although this is not described in Figure 3.

Figure 4 is a flowchart showing a procedure for mounting a write-once optical disc, when the disc is loaded into a drive apparatus, a file system or device driver of the present invention initially proceeds for the disc.

In step S201, media type recognition is performed. Specifically, it is confirmed that the disc is of the write-once type and the drive supports pseudo overwritable function for the disc.

In step S202, by requesting the track information of a write-once optical disc to a drive apparatus, the information about the size and the location of each track, and next writable address in each track are obtained. In order to record data into a reserved track, the above-described information needs to be checked in advance.

In step S203, it is checked whether or not an unrecorded area in each track has a prescribed size or more. When the size of the unrecorded area is less than a prescribed size, the optical disc is used as a read-only disc. When the size is equal to or greater than a prescribed size, the procedure goes to the next step.

In step S204, the drive apparatus is instructed to read the Metadata Bitmap file area. As a result, the Metadata Bitmap is obtained.

In step S205, it is checked whether or not there is available sectors in the Metadata File, or whether or not there are available sectors having a prescribed size or more. For example, when the size of the available area is less than 1 MB, go to step S206. When the size is equal to or greater than a prescribed size, this disc can be handled as recordable disc. When only File Entries are recorded in an available area of 1 MB, File Entries corresponding to 512 files at most can be recorded. This will require 512 ECC blocks at most after next writable address in the track to substantially guarantee Pseudo-overwrite operations with respect to available sectors. Therefore, if the size of unrecorded area of the track is less than prescribed size, go to step S206 without checking available area in Metadata File.

When the data is not recorded correctly in some sectors due to defective sectors, the data is replaced within the Spare area or into the track. Therefore, additional unrecorded area is needed to recover defective sectors on the disc.

In step S206, some area including recorded area in an track for user data recording is closed, and a track having a prescribed size is assigned in the incomplete track as an additional recording area for Metadata File. The assigned area is allocated as an additional area for a Metadata File.

Figure 5 is a flowchart showing a method for checking whether or not a disc is recordable before a file is recorded onto the disc by a recording method according to the present invention.

In step S301, a drive apparatus is instructed to read an area in the Metadata Bitmap file. The Metadata Bitmap is obtained.

In step S302, it is checked whether or not there is available sectors in the Metadata File, or whether or not there is available sectors having a prescribed size or more. When the size of available sectors is less than the

prescribed size, go to step S303. When the size is equal to or greater than the prescribed size, the procedure goes to the next step S304.

Step S303 and Step S306 is the same as step S206 in Figure 4.. In these step, new track is assigned as reserved track to allocate additional recording area for Metadata File.

In step S304, by requesting the track information of a reserved track for metadata recording to the drive apparatus, the information is obtained.

In step S305, it is checked whether or not there is an unrecorded area following the next writable address of the track for metadata recording, or whether or not the size of the unrecorded area is equal to or greater than a prescribed size. The minimum prescribed size should be one ECC block size. When the size is less than the prescribed size, go to step S306, else the procedure goes to the next step S307.

In step S307, in order to allocate some area for metadata in the Metadata File, the Metadata Bitmap is read into a memory, and is updated in the memory. In case of rewritable media, if some metadata is deleted, deleted area become available space. However, on write-once media, deleted area is not used for recording. Then, the bit corresponding to the deleted area is not changed in Metadata Bitmap.

As above mentioned, this idea is pseudo-overwrite is used, mainly, if the data have to be updated, and is not used for deleted area and newly recording area.

In step S308, a directory, under which a file is to be registered, is read into the memory, and is updated in the memory. The File Entry of the directory is also read into the memory, and information (e.g., size and update time, etc.) of the directory is updated.

In step S309, by requesting the track information of a track for user data recording to the drive apparatus, the information is obtained.

In step S310, it is checked whether or not there is an unrecorded area following the next writable address of the track for user data recording, or whether or not the size of the unrecorded area is equal to or greater than a prescribed size. The minimum prescribed size should be one ECC block size or the size of the data to be recorded. When the size is less than the prescribed size, a record operation is ended. In this case, data is updated in a memory. Therefore, even when a record operation is ended, a inconsistent data structure is not generated on the optical disc. When the size is equal to or greater than the prescribed size, the procedure goes to the next step S311.

In step S311 the data of a file is recorded from the next writable address in a track for user data recording.

In step S312, in order to register the address information of the recorded data, the File Entry of the file is generated in a memory.

In step S313, the data updated or generated in the memory is recorded. It is instructed that the Metadata Bitmap file, the directory, the File Entry of the directory, and the File Entry of the file, are recorded onto the optical disc.

In step S314, it is instructed that the logical volume integrity descriptor is updated in order to indicate the integrity state of the file management information. A pseudo-overwrite operation is performed.

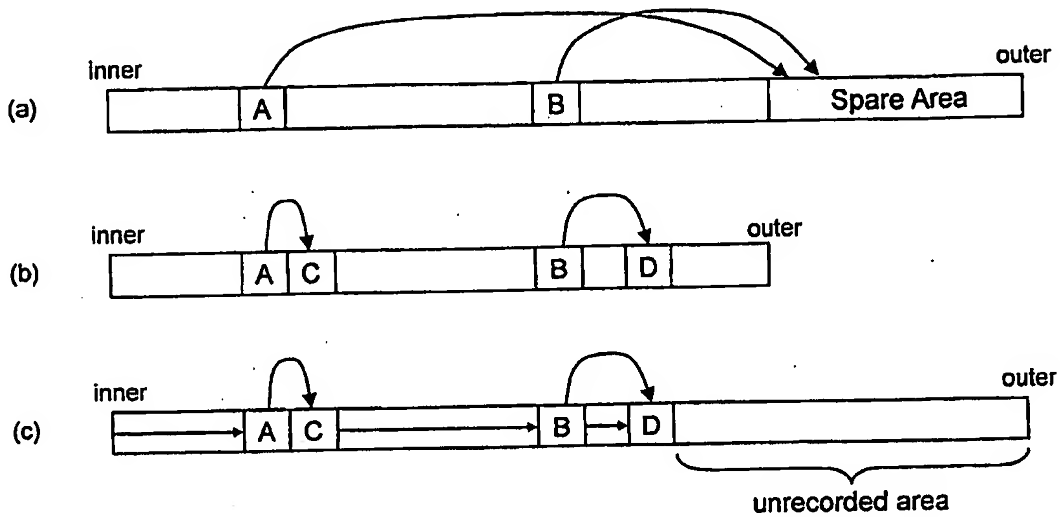
As described in step S313, by recording a plurality of pieces of data together so that as many of the pieces of data as possible are recorded in the same ECC block (recording timing) by using a cache, it is possible to effectively utilize an unrecorded area in the Spare Area and the track. Particularly, a Metadata Bitmap or a Logical Volume Integrity Descriptor may not be updated every time a file is recorded. By recording the Metadata Bitmap or the Logical Volume Integrity Descriptor after a plurality of files have been recorded, it is possible to effectively use an unrecorded area of the spare area or the track.

WHAT IS CLAIMED IS:

1. All embodiments discussed and disclosed above.

2. A recording method for Universal Disk Format (UDF) without a virtual allocation table.

Figure 1



(a)
inner
A
B
outer
Spare Area
(b)
inner
A
C
B
D
outer
(c)
inner
A
C
B
D
outer
unrecorded area

Figure 2

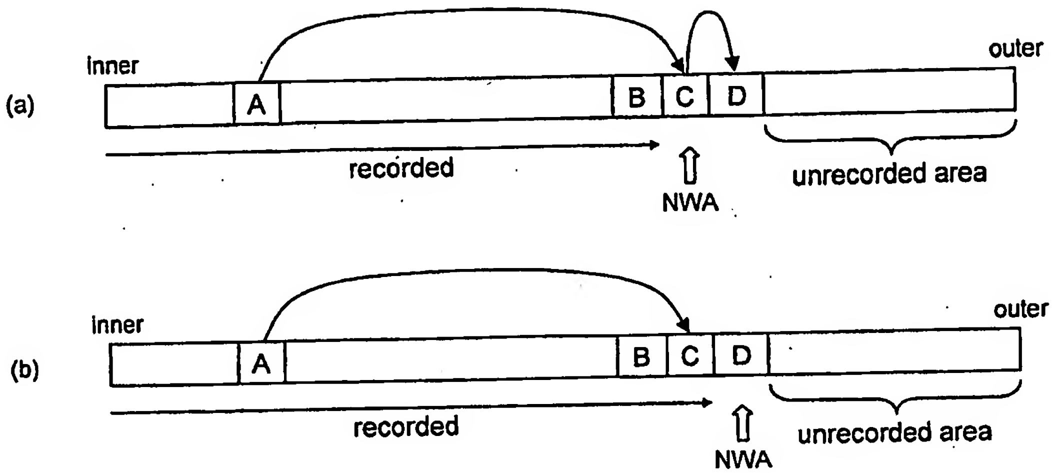
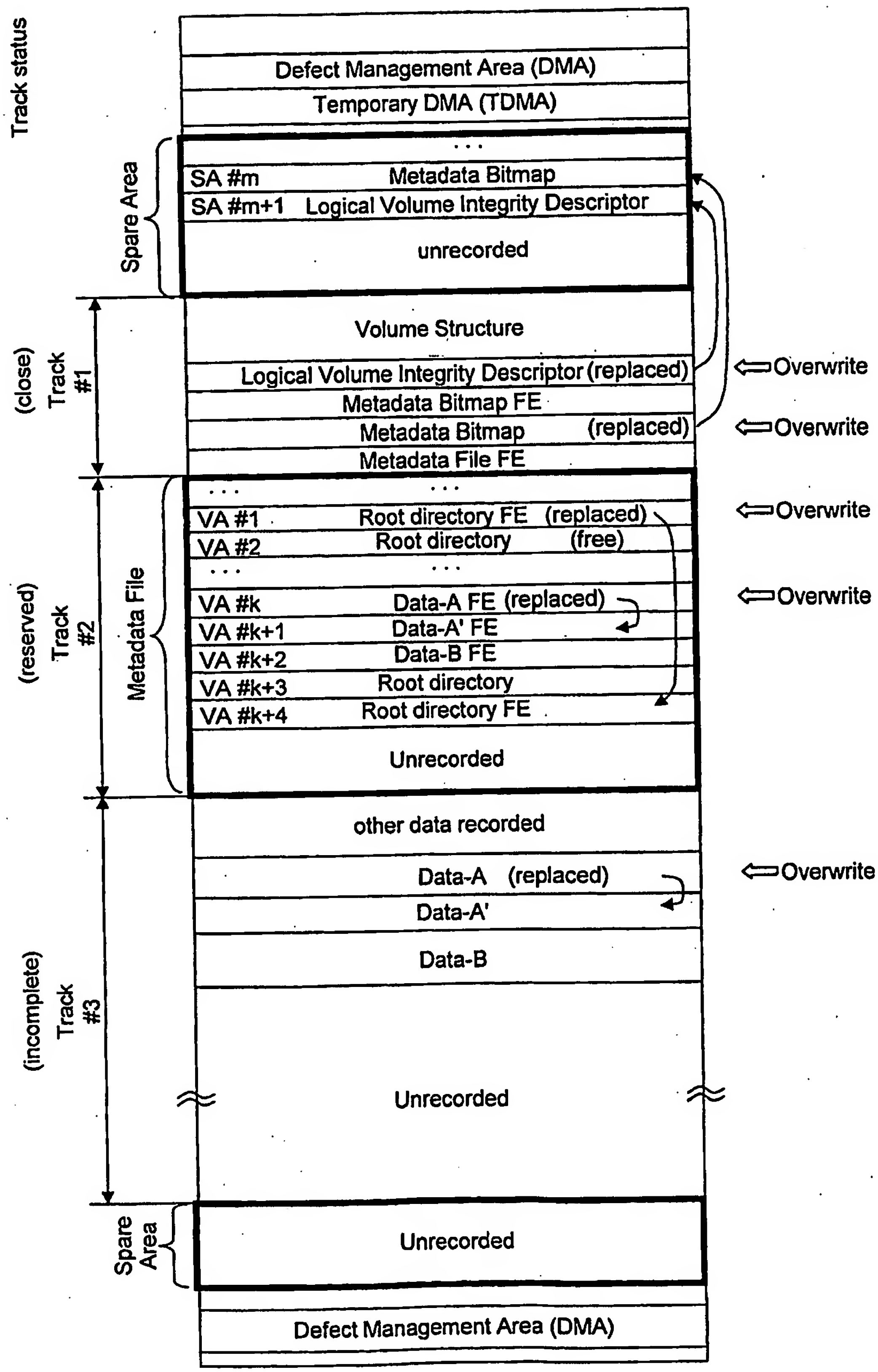

inner
outer
(a)
A
B
C
D
recorded
NWA
unrecorded area
inner
outer
(b)
A
B
C
D
recorded
NWA
unrecorded area

Figure 3



Track status
Defect Management Area (DMA)
Temporary DMA (TDMA)
Spare Area
SA #m
Metadata Bitmap
SA #m+1
Logical Volume Integrity Descriptor
unrecorded
(close)
Track #1
Volume Structure
Logical Volume Integrity Descriptor (replaced)
Overwrite
Metadata Bitmap FE
Metadata Bitmap (replaced)
Overwrite
Metadata File FE
(reserved)
Track #2
Metadata File
VA #1
Root directory FE (replaced)
Overwrite
VA #2
Root directory (free)
VA #k
Data-A FE (replaced)
Overwrite
VA #k+1
Data-A' FE
VA #k+2
Data-B FE
VA #k+3
Root directory
VA #k+4
Root directory FE
Unrecorded
(incomplete)
Track #3
other data recorded
Data-A (replaced)
Overwrite
Data-A'
Data-B
Unrecorded
Spare Area
Unrecorded
Defect Management Area (DMA)

Figure 4

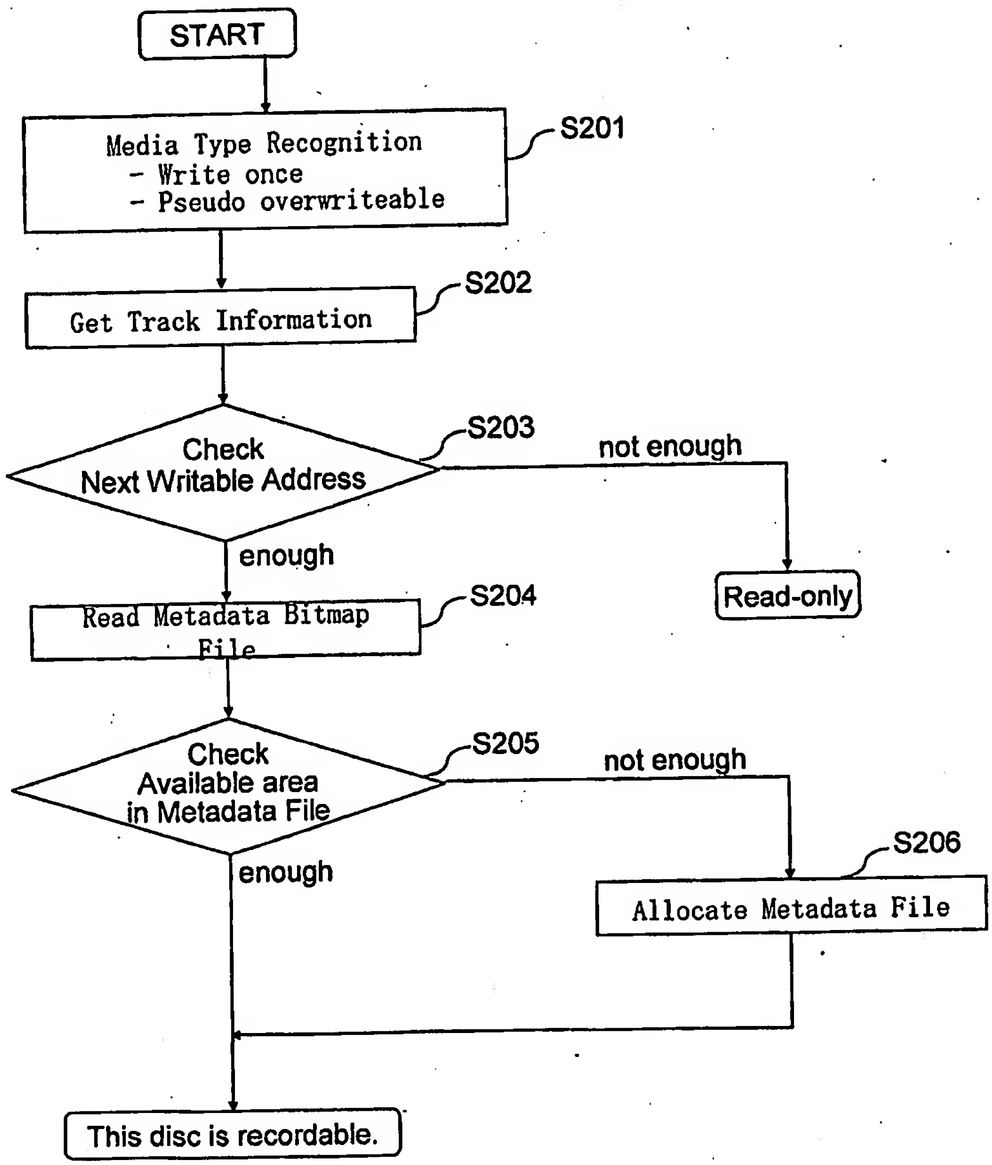
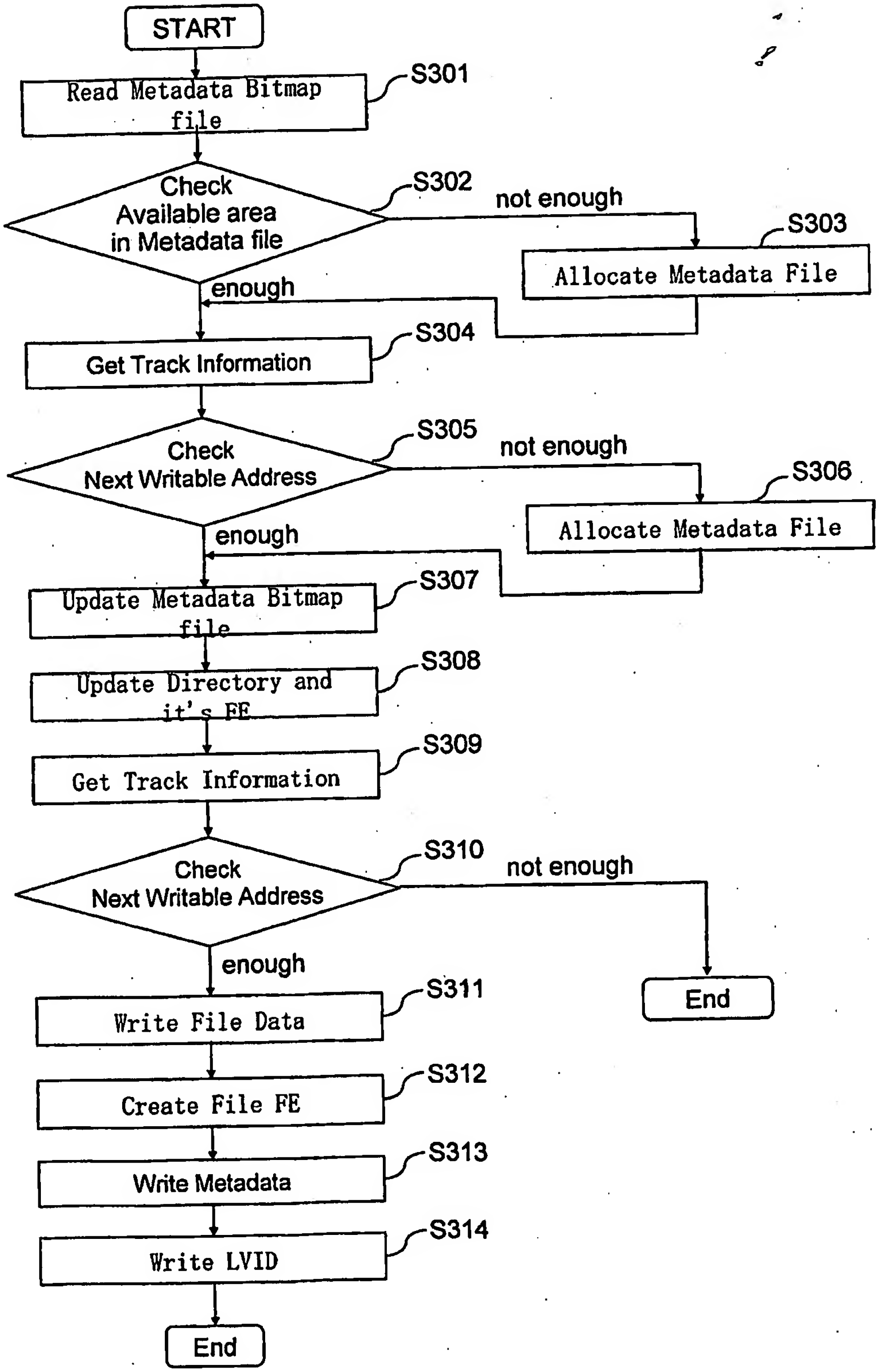

START
Media Type Recognition
- Write once
- Pseudo overwriteable
S201
Get Track Information
S202
Check
Next Writable Address
S203
not enough
Read-only
enough
Read Metadata Bitmap File
S204
Check
Available area
in Metadata File
S205
not enough
S206
Allocate Metadata File
enough
This disc is recordable.

Figure 5


START
Read Metadata Bitmap file
S301
Check Available area in Metadata file
S302
not enough
S303
Allocate Metadata File
enough
Get Track Information
S304
Check Next Writable Address
S305
not enough
S306
Allocate Metadata File
enough
Update Metadata Bitmap file
S307
Update Directory and it's FE
S308
Get Track Information
S309
Check Next Writable Address
S310
not enough
enough
End
Write File Data
S311
Create File FE
S312
Write Metadata
S313
Write LVID
S314
End

Application Data Sheet

Application Information

Application number::	Express Mail No. ER559458466US
Filing Date::	April 4, 2005
Application Type::	Provisional
Subject Matter::	Utility
Suggested classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	None
Number of CD disks::	
Number of copies of CDs::	
Sequence submission?::	
Computer Readable Form (CRF)?::	
Number of copies of CRF::	
Title::	Universal Disk Format (UDF) on Write-Once Media Without a Virtual Allocation Table (VAT)
Attorney Docket Number::	4670
Request for Early Publication?::	NO
Request for Non-Publication?::	NO
Suggested Drawing Figure::	
Total Drawing Sheets::	4
Small Entity?::	NO
Latin name::	
Variety denomination name::	
Petition included?::	NO
Petition Type::	
Licensed US Govt. Agency::	NO
Contract or Grant Numbers::	
Secrecy Order in Parent Appl.?::	NO

Applicant Information

Applicant Authority Type::	Inventor
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Correspondence Customer Number:: 000039254

Representative Information

Representative Customer Number:: 000039254

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::

Foreign Priority Information

Country::	Application number::	Filing Date::	Priority Claimed::

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Assignee name:: Microsoft Corporation

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